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CHESS - FOUNDATION FOR MATHEMATICS: IN WHAT WAYS CAN CHESS IMPROVE A CHILD'S MATHEMATICAL SKILLS?

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ABSTRACT

This paper aims to find and explore the positive correlation between chess and mathematics. It further discusses how the skills required for chess are also of great importance in mathematics. Moreover, chess problems that need to be solved using mathematical concepts are added to persuade children to try and come up with their own problems and solutions. Creative and critical thinking are two other important skills supported by chess. Through examples, the paper demonstrates how these skills correlate with chess. Towards the end, the paper advocates for the introduction of chess in schools, backed up by previous efforts to promote chess in schools. Chess is a game that requires the use of one's mental aptitude as well as strategic thinking skills. It was found that these abilities are useful in various areas of life, notably mathematics. It aids in the development of various skills: it strengthens basic calculations, improves memorization ability, enhances concentration power, develops foresight, and instills time management.

KEYWORDS: Critical Thinking, Mental Aptitude, Supplement, Time Management, Concentration Power, Foresight.

INTRODUCTION

As children, many of us may have engaged in chess either as part of our school curriculum or as a recreational activity with friends. However, beyond its entertainment value, chess offers numerous cognitive benefits. It serves as a means to relax the mind amidst the rigors of daily life while simultaneously enhancing cognitive abilities.

According to the European Parliament (2012), chess has been recognized for its capacity to improve children's concentration, patience, persistence, and creativity. Moreover, it fosters intuition, memory, and analytical and decision-making skills. Additionally, chess instills values such as determination, motivation, and sportsmanship.

Further substantiating these claims, studies conducted in both Canada and the United States have revealed significant enhancements in memory, verbal reasoning, and mathematical problem-solving skills among elementary school students who engage in chess. These findings underscore the multifaceted benefits of incorporating chess into educational curricula and extracurricular activities.

METHODOLOGY

Utilizing a secondary qualitative research approach, this paper delves into existing literature to explore the correlation between chess and mathematical skills. This methodology was chosen due to the nature of the topic, which is heavily influenced by findings from previous studies and does not involve direct comparison or numerical analysis.

While this approach provides valuable insights from a diverse range of sources, it is not without limitations. One such limitation is the potential for researcher bias, where the author's interpretation may be influenced by personal opinions rather than empirical data. Despite this drawback, the comprehensive review of existing literature offers a nuanced understanding of the topic and lays the foundation for further inquiry.

RESULTS & DISCUSSION

Numerous researchers have argued that chess can improve students' educational performance (Smith & Cage, 2000; Scholz et al., 2008; Kazemi et al., 2012; Trinchero, 2013; Jerrim et al., 2016). Sala & Gobet (2017) stated that chess "combines numerical, spatial, temporal, and combinatorial aspects and helps foster attention, problem solving, and self-monitoring of thinking (i.e., metacognition)". However, Gobet & Campitelli (2006) argued that "the educational effects of chess training remain undetermined" and that "compulsory chess instruction may engender motivational problems among students."

Chess and its influence on math

Firstly, each piece holds a specific value. For example, the queen is worth 9 points, but a bishop is worth just 3 points. Thus, it would be counterproductive to swap a queen for a bishop because the player would lose 6 points. This can help young children improve their fundamental subtraction abilities.

Secondly, openings are a must for chess players. They are a set of fixed moves that both sides play in the beginning, and when executed perfectly, they may lead to a successful middle game. The same scenario exists in mathematics, where a person must master formulas to answer problems. Chess can therefore help to strengthen one's memory (Ortiz et al., 2019). Even within openings, there exist variations. So, a chess player is required to understand - and often memorize - numerous variations in order to be able to play against them.

Thirdly, chess requires the utmost use of the mind to foresee any threat posed by the opponent; one wrong move may cost the player the whole game. The same is true for math; one wrong step or calculation can invalidate the entire answer. Thus, it inculcates a very important skill - *concentration* (Gobet & Campitelli, 2006).

Furthermore, it develops a sense of farsightedness (Tanajan et al., 2012). One needs to think many moves ahead to ensure that they avoid making a mistake while moving. Similarly, in mathematics, we are required to solve several steps in our heads.

Moreover, *critical thinking* is another crucial skill set that chess promotes (Feruson, 2012; Ortiz et al., 2019). There are several sorts of puzzles in chess, such as mate in one, two, three, or more moves. All of these require the person to thoroughly analyze the situation before acting. Similarly, one must thoroughly understand a word problem in mathematics in order to solve it.

Additionally, most chess games are time-bound, i.e., one must think and act fast to avoid losing time. The opening should be played out quickly to save time for the middle and end games. In modes like rapid and blitz, one is sometimes required to move within a fraction of seconds. Similarly, in mathematics, one needs to solve questions within a particular time frame; they cannot allocate too much time to one question, otherwise, they risk missing out on completing the others. Thus, it teaches us the value of *time management*.

This paper now explores some mathematical problems involving the chessboard. There are several questions that may be constructed, and students can create their own questions and then answer them. Thus, chess also fosters *creativity* (Ortiz et al., 2019). For example, how many combinations are possible for the starting move of both black and white?

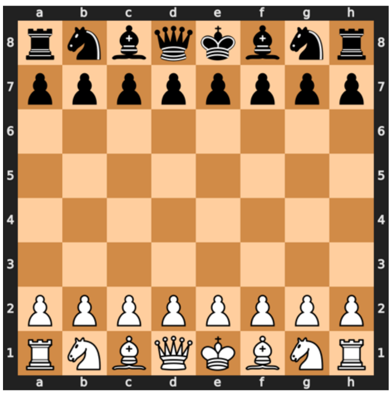

Figure 1: A standard chess board

White can move one pawn in two different ways. Hence, a player can move 8 pawns in 16 ways. For example, the pawn at e2 can be moved in two ways, e4 and e3, and the pawn at d2 can be moved in two other ways, d3 and d4.

Likewise, one knight can be moved in two different ways, and two knights can be moved in four ways. The knight at b1 can be moved to c3 and a3; the knight at g1 can be moved to f3 and h3. However, no other piece except for the knight and the pawn can be used as a first move as they are blocked by the pawns. Hence, white has 20 combinations with them, and they can choose their starting move in $20C_1$ ways (C_1 here is the choice from 20 options).

In the same way, black can select their starting move in $20C_1$ ways.

Therefore, total number of starting positions = $20C_1 \times 20C_1 = 20 \times 20 = 400$

Another problem could be how many rectangles are there which are not squares?

If you have a look at the chessboard, you can see that there's a total of 9 lines each horizontally and vertically. Out of these lines, a rectangle can be formed by selecting any two lines, both horizontally and vertically. Thus, the number of rectangles = $9C_2 \times 9C_2 = [9 \times 8/2]^2 = 1296$. However, these are the number of rectangles, including the squares. As a result, we'll have to subtract the number of squares.

Number of 1×1 squares = 8^2
Number of 2×2 squares = 7^2
…………..
Number of 8×8 squares = 1^2
Hence, the number of squares = $8^2 + 7^2 + 6^2 + 5^2 + 4^2 + 3^2 + 2^2 + 1^2 = 64 + 49 + 36 + 25 + 16 + 9 + 4 + 1 = 204$
OR
$\sum 8^2 = 8 \times (8+1) \times (16+1) /6 = 204$
$[\sum n^2 = n(n+1)(2n+1) / 6]$

Therefore, the number of rectangles that are not squares is 1296–204=1092. In this way, one can form their own questions and hone their mathematical skills.

The Knight's Tour

Leonhard Euler, a famous mathematician and physicist, created a semi-magic square, which was also another solution for the infamous Knight's Tour Problem. A magic square is one in which the sum of all the numbers in each row, column, and diagonal is the same. The Knight's Tour is a sequence of moves by a knight that enables it to traverse the entire board.

1	48	31	50	33	16	63	18
30	51	46	3	62	19	14	35
47	2	49	32	15	34	17	64
52	29	4	45	20	61	36	13
5	44	25	56	9	40	21	60
28	53	8	41	24	57	12	37
43	6	55	26	39	10	59	22
54	27	42	7	58	23	38	11

Figure 2: A chess board depicting the squares taken by the knight to traverse the entire board

The knight was placed in the position labeled 1 and was moved through the entire board until the 64th square. The sum of each row and column adds up to 260. For instance, the sum of the numbers in the first row is 1+48+31+50+33+16+63+18 = 260. The sum of all the numbers in the first column is 1+30+47+52+5+28+43+54 = 260.

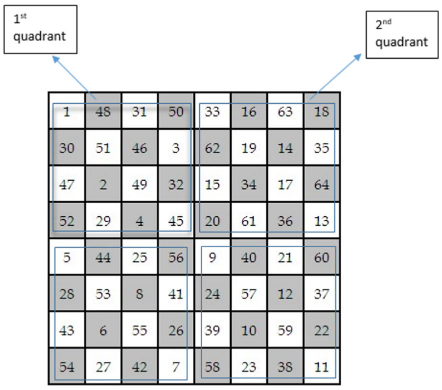

Figure 3: A chess board depicting quadrants

Surprisingly, the sum of all the numbers in each quadrant is also the same, i.e., 520.

Moreover, the sum of each half row and half column adds up to 130.

The sum of the first half row is 1+48+31+50 or 33+16+63+18 = 130

The sum of the first half column is 1+30+47+52, or 54+43+28+5 = 130.

Unfortunately, the sum of each of the diagonals does not add up to 260.

The sum of numbers on the first diagonal is 1+51+49+45+9+57+59+11= 282

The sum of numbers on the second diagonal is 18+14+34+20+56+8+6+54=210

Thus, the chess board is a place where one can combine his thinking skills along with his mathematical knowledge to come up with possible solutions for a problem. All these problems are a testament to the above statement.

RECOMMENDATIONS

Introduction of Chess in schools

As highlighted at the outset of this paper, the European Parliament extensively detailed the manifold benefits of chess, extending beyond mathematics to various other domains. The Chess in Schools program, endorsed by the European Parliament, stands as a testament to this advocacy for the introduction of chess in educational curricula. For instance, the NYCHESS initiative dispatches seasoned chess instructors to schools to establish chess programs. These instructors conduct five lessons and collaborate with teachers to sustain the program, with support from high school chess players and local students proficient in chess (Palm, 1990, pp. 4-5). Similarly, the 'Chess in Schools and Communities' program, operating in the UK, endeavors to introduce chess to schools and inner-city communities, partnering with over 300 schools nationwide. These initiatives underscore the growing momentum behind integrating chess into educational frameworks. Hence, instilling chess in students from a young age promises significant benefits for schools and students alike, nurturing young minds and fostering multifaceted skill development.

Installation of chess schools or centers

The establishment of chess schools or centers represents a pivotal step towards promoting chess education. In a recent development, the Odisha government forged a partnership with FIDE, aiming to proliferate chess by establishing 100 training centers across the state. Concurrently, they inaugurated the Pro Chess Ta state-level academy and launched the Chess in School project. Noteworthy initiatives by renowned figures, such as former world chess champion Anatoly Karpov, have also contributed to this cause. Karpov's International School of Chess, founded in Lindsborg, USA, in 2003, stands as a beacon for chess education. Moreover, in the UK, the government's commitment to chess is evident through Prime Ministerial endorsement, with plans to allocate £500,000 to the English Chess Federation (ECF) for expanding the game in state schools and installing 100 chess tables in public parks. Such collaborative endeavors between governments and individuals are instrumental in fostering the growth and accessibility of chess.

CONCLUSION

Chess serves as a catalyst for enhancing critical life skills, many of which underpin mathematical proficiency. Encouraging young individuals to engage in this game can profoundly enrich their cognitive development. Therefore, it is imperative that schools integrate chess into their educational framework, as it offers a holistic approach to skill-building. By incorporating chess into the curriculum, students can refine essential attributes like time management, critical thinking, foresight, and concentration. Furthermore, the establishment of dedicated chess schools or centers can serve as focal points for promoting the game and nurturing talent. To augment the benefits of chess, pairing it with other mentally stimulating activities like Sudoku can yield synergistic outcomes. The example problems provided earlier are not intended to offer solutions but rather to inspire creative problem-solving and encourage exploration of diverse challenges. This approach cultivates a mindset of unlimited potential and fosters creativity among learners. Moreover, future research endeavors could employ primary research methods to validate and expand upon the findings presented in this paper, thereby advancing the knowledge base in this field.

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